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C037511(037)

B. Tech. (Fifth Semester) Examination,
Nov.-Dec. 2023

(New Scheme)

(Mech. Engg. Branch)

INTERNAL COMBUSTION ENGINE

Time Allowed : Three hours

Maximum Marks : 100

Minimum Pass Marks : 35

Note : *Attempt all questions. Part (a) of each question is compulsory and carries 4 marks. Attempt any two parts from (b), (c) and (d) and each carries 8 marks. Draw with neat sketches where required.*

Unit-I

1. (a) What is the normal range of compression ratio for SI and CI Engines? 4

(b) What do you mean by valve timing diagram? With a neat sketch explain the valve timing diagram for four stroke low speed SI Engines. 8

(c) Compare SI and CI Engines with respect to different important parameters. 8

(d) Describe with a neat sketch the working principle of a crankcase scavenged two-stroke engine. 8

Unit-II

2. (a) Define stochiometric (chemically correct) air fuel ratio. 4

(b) Explain with suitable sketches the combustions phenomena in SI engines and explain the three stages of combustion in SI engines. 8

(c) Explain the phenomenon of knock in CI engines and compare it with SI engine knock. 8

(d) Explain the various factors that influence the flame speed. 8

Unit-III

3. (a) Define carburetion. 4

(b) Explain with diagram the operation of modern carburetor at : 8

(i) Metering system

(ii) Idling system

(c) Derive an expression for air-fuel ratio of a simple carburetor. 8

(d) The venturi of a simple carburetor has a throat diameter of 20 mm and the coefficient of flow is 0·8. The fuel orifice has a diameter of 1·14 mm and the coefficient of fuel is 0·65. The gasoline surface is 5 mm below the throat.

Calculate :

(i) The air fuel ratio for a pressure drop of 0·08 bar when the nozzle tip is neglected.

(ii) The air fuel ratio when the nozzle tip is taken into account.

(iii) The minimum velocity of air or critical air velocity required to start the fuel flow when the nozzle tip is provided.

Assume the density of air and fuel to be 1·20 kg/m^3 and 750 kg/m^3 respectively. 8

Unit-IV

4. (a) What are the functions of lubricant in IC engine? 4

(b) How knock emissions are caused and what are their effects on environment? 8

(c) Explain the following : 8

(i) Thermosyphon cooling system

(ii) Forced circulation cooling system

(iii) Evaporative coolIng system

(d) Explain and compare the wet sump dry sump lubrication systems. 8

Unit-V

5. (a) Define volumetric efficiency and relative efficiency. 4

(b) Explain any three characteristics of SI engine with reference to their performance. 8

(c) Describe the "Morse Test". Make comments on 'assumptions made' & precaution taken' in performing the test. 8

(d) The following detail were noted in a test on a four cylinder, four stroke engine, diameter = 100 mm;

stroke = 120 mm; speed of the engine = 1600 rpm; fuel consumption = 0·2 kg/min; Calorific value of fuel is 44000 kJ/kg; Difference in tension on either side of the brake pulley = 40 kg; Break circumference is 300 cm. If the mechanical efficiency is 80%.

Calculate :

(i) Brake thermal efficiency

(ii) Indicated thermal efficiency

(iii) Indicated mean effective pressure and

(iv) Brake specific fuel consumption 8

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C037512(037)

B. Tech. (Fifth Semester) Examination, Nov.-Dec. 2023

(New Scheme)

(Mech. Engg. Branch)

SOLID MECHANICS

Time Allowed : Three hours

Maximum Marks : 100

Minimum Pass Marks : 35

Note : *Attempt any two parts from each unit. Assume any data if missing. The figures in the right hand margin indicate marks.*

Unit-I

1. (a) A bar 100 cm in length is subjected to an axial pull, such that the maximum stress is equal to 150 MN/m^2. Its area of cross section is 2 cm^2 over a length

of 95 cm and for the middle 5 cm length it is only 1 cm^2. If E = 200 GN/m^3, calculate the strain energy stored in bar. 10

(b) State and ptove Castigliano's theorem. 10

(c) A simple supported beam of span L is carrying a concentrated load W at centre and a u.d.l. of w per unit length. Show that Maxwell's reciprocal theorem holds good at the centre of the beam. 10

Unit-II

2. (a) State and deduce the Clapeyron's three moment equation. 10

(b) A fixed beam of 6 m span is loaded with point loads of 150 kN at a distance 2 m from each support. Draw the B. M. and S. F. diagrams. Find also the maximum deflection. Take : E = 2×10^8 kN/m^2, and I = 8×10^8 mm^4. 10

(c) Fig. 1 shows a continuous beam ABCD having three equal spans of length l each. It carries a u.d.l. w/unit length over its entire length. it is freely supported on all supports, which are at the same level. Draw the B.M. and S.F. diagrams for this beam. 10

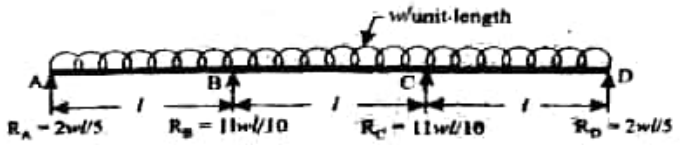

Fig.1

Unit-III

3. (a) The ends of a thin cylinder, 180 mm internal diameter and wall thickness 3 mm are closed by rigid plates and it is then filled with a liquid. When an axial compressive force of 33·6 kN is applied to the cylinder, the pressure of the liquid rises by 72 kN/m^2. If E = 200 GN/m^2 and Poisson's ratio is 0·3, find the bulk modulus of the liquid. 10

(b) Derive expression for radial and hoop stresses along thickness of thick cylinders. 10

(c) Find the ratio of thickness to internal diameter for a tube subjected to internal pressure when the pressure is 5/8 of the value of the maximum permissible circumferential stress.

Find the increase in internal diameter of such a tube 100 mm internal diameter when the internal pressure is 80 72 MN/m^2.

Also find the change in wall thickness. E = 205 72 GN/m^2 and 1/m = 0·29. 10

Unit-IV

4. (a) Derive an expression for Euler's crippling load for long column with one end fixed and other end hinged. 10

(b) Find the Euler crushing load for a hollow cylindrical cast-iron column 200 mm external diameter, 25 mm thick, 6 m long and hinged at both ends. E = 120 GN/m^2.

Compare the load with the crushing load as given by the Rankine formula taking σ_c = 550 MN/m^2, and a = 1/1600.

For what length of column would these two formulae give the same crushing load? 10

(c) A beam of T-section (flange : 100 mm × 20 mm; web : 150 mm × 10 mm) is 2·5 meters in length and is simply supported at the ends. It carries a load of 3·2 kN inclined at 20° to the vertical and passing through the centroid of the section. 10

Unit-V

5. (a) Discuss several governing equations of plane stresses in cylindrical coordinates. 10

(b) Explain applications of plane stresses and plane strain to rotating discs. 10

(c) Write short notes on : 10

(i) Thermo-elasticity

(ii) Governing equation of plane strain for spherical coordinate

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C037513(037)

B. Tech. (Fifth Semester) Examination, Nov.-Dec. 2023

(New Scheme)

(Mech. Engg. Branch)

FLUID MACHINES

Time Allowed : Three hours

Maximum Marks : 100

Minimum Pass Marks : 35

Note : *Attempt all questions. From each question part (a) is compulsory and carries 4 marks and attempt any two parts from (b), (c) and (d) each carries 8 marks.*

Unit-I

1. (a) Define boundary layer thickness and displacement thickness. 4

(b) Define Energy Thickness. Derive an expression for the energy thickness.

$$\delta^{**} = \int_0^{\delta} \frac{u}{U}\left[1 - \frac{u}{U^2}\right] dy$$ 8

(c) A metallic ball of diameter 2×10^{-3} m drops in a fluid of sp. Gr. 0.95 and viscosity 15 poise. The density of the metallic ball is 12000 kg/m^3.

Find : 8

(i) The drag force exerted by fluid on metallic ball,

(ii) The pressure drag and skin friction drag,

(iii) The terminal velocity of ball in fluid.

(d) The air having a velocity of 40 m/s is flowing over a cylinder of diameter 1·5 m and length 10 m, when the axis of the cylinder is perpendicular to the air stream. The cylinder is rotated about its axis and a lift of 6867 N per metre length of the cylinder is developed. Find the speed of rotation and location of the stagnation points. The density of air is given as 1·25 kg/m^3. 8

Unit-II

2. (a) Define the terms : 4

(i) Impact of jets, and

(ii) Jet Propulsion

(b) Find an expression for the efficiency of a series of moving curved vanes when a jet of water strikes the vanes at the one of tips. 8

(c) Define the term 'Governing of a turbine'. Describe with the neat sketch of governing of Pelton turbine. 8

(d) The penstock supplies water from a reservoir to the Pelton wheel with a gross head of 500 m. One-third of the gross head is lost in friction in the penstock. The rate of flow of water through the nozzle fitted at the end of the penstock is 2·0 m^2/s. The angle of deflection of the jet is 165°. Determine the power given by the water to the runner and also hydraulic efficiency of the Pelton wheel. Take speed ratio = 0·45 and C_v = 1·0. 8

Unit-III

3. (a) What is Cavitation? How can it be avoided in reaction turbine? 4

(b) A turbine is to operate under a head of 25 m at 200 r.p.m. the discharge is 9 m^3/s. if the efficiency is

90%, determine the performance of the turbine under a head of 20 metres. 8

(c) Define the terms : specific speed of a turbine, unit speed, unit power and unit rate of flow of a turbine. Derive th expression for specific speed and unit speed. 8

(d) Explain and write the characteristics curves of hydraulic turbines. 8

Unit-IV

4. (a) Define the terms; Hydraulic machines, Turbines and pumps. 4

(b) Define specific speed of a centrifugal pump. Derive an expression for the same. 8

(c) A centrifugal pump with a 1·2 m diameter runs at 200 r.p.m. and pumps 1880 liters/s, the average lift being 6 m. The angle which the vanes make at exit with the tangent to the impeller is 26° and the radial velocity of flow is 2·5 m/s. Determine the manometric efficiency and the least speed to start pumping against a head of 6 m, the inner diameter of the impeller being 0·6 m. 8

(d) A centrifugal pump delivers water against a net head of 14·5 metres and a design speed of 1000 r.p.m. The vanes are curved back to an angle of 30° with the periphery. The impeller diameter is 300 mm and the outlet width 50 mm. Determine the discharge of the pump if manometric efficiency is 95%. 8

Unit-V

5. (a) What is an air vessel? Describe the function of the air vessel for reciprocating pumps. 4

(b) Derive an expression for the head lost due to friction in the delivery pipe of a reciprocating pump with and without air vessel. 8

(c) The length and diameter of a suction pipe of a single-acting reciprocating pump are 5 m and 10 cm respectively. The pump has a plunger of diameter 15 cm and a stroke length of 35 cm. The center of the pump is 3 m above the water surface in the pump. The atmospheric pressure head is 10·3 m of water and pump is running at 35 r.p.m. 8

Determine:

(i) Pressure head due to acceleration at the beginning of the suction stroke,

(ii) Maximum pressure head due to acceleration and

(iii) Pressure head in the cylinder at the beginning and at the end of the stroke

(d) A single-acting reciprocating pump has a plunger diameter of 250 mm and stroke of 450 mm and it is driven with S.H.M. at 60 r.p.m. the length and diameter of the delivery pipe are 60 m and 100 mm respectively. Determine the power saved in overcoming friction in the delivery pipe by fitting an air vessel on the delivery side of the pump. Assume the friction factor = 0·01 8

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C037514(037)

B. Tech. (Fifth Semester) Examination,
Nov.-Dec. 2023

(New Scheme)

(Automobile Engg. Branch)

DYNAMICS of MACHINES

Time Allowed : Three hours

Maximum Marks : 100

Minimum Pass Marks : 35

Note : *Attempt all questions. Part (a) of each question is compulsory and carry equal 4 marks. Attempt any* ***two*** *parts from (b), (c) and (d) in all the units & carries equal 8 marks*

Unit-I

1. (a) Explain the governor and their types. **4**

(b) A porter governor has all four arms 250 mm long. The upper arms are attached on the axis of rotation and the lower arms are attached to the sleeve at a

distance of 30 mm from the axis. The mass of each ball is 5 kg and the sleeve has a mass of 50 kg. The extreme radii of rotation are 150 mm and 200 mm. Determine the range of speed of the governor. 8

(c) A Hartnell governor having a central sleeve spring and two right-angled bell crank levers moves between 290 rpm and 310 rpm for a sleeve lift of 15 mm. The sleeve arms and the ball arms are 80 mm and 120 mm respectively. The levers are pivoted at 120 mm from the governor axis and mass of each ball is 2·5 kg. The ball arms are parallel to the governor axis at the lowest equilibrium speed.

Determine : 8

(i) Loads on the spring at the lowest and the highest equilibrium speeds,

(ii) Stiffness of the spring.

(d) A Porter governor has equal arms 200 mm long pivoted on the axis of rotation. The mass of each ball is 3 kg and the mass on the sleeve is 15 kg. The ball path is 120 mm when the governor begins to lift and 160 mm at the maximum speed. Determine the range of speed.

If the friction at the sleeve is equivalent to a force of 10 N, find the coefficient of insensitiveness. 8

Unit-II

2. (a) Explain the terms :

Static balancing, dynamic balancing, Surveying couple, hammer blow. 4

(b) Four masses m_1, m_2, m_3, m_4 are 200 kg, 300 kg, 240 kg and 260 kg respectively. The corresponding radii of rotation are 0·2 m, 0·15 m, 0·25 m and 0·3 m respectively and the angles between successive masses are the 45°, 75° and 135°. Find the position and magnitude at the balance mass required, if its radius of rotation is 0·2 m using graphical method only. 8

(c) Four masses A, B, C and D as shwon below are to be completely balanced :

	A	B	C	D
mass (kg)	—	30	50	40
Radius (mm)	180	240	120	150

The planes containing masses B and C are 300 mm apart. The angle between planes containing B and

C is 90°. B and C make angles of 210° and 120° respectively with D in the same sense.

Find : 8

(i) The magnitude and the angular position of mass A

(ii) The position of planes A and D.

(d) Prove the equation of resultant primary forces of "v" engines. 8

Unit-III

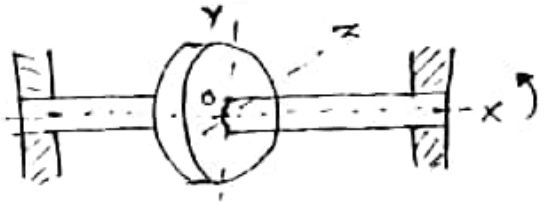
3. (a) Explain the gyroscopic effect on aircraft. 4

(b) Discuss about the effect of gyroscopic couple on a naval ship during steering, pitching and rolling. 8

(c) Discuss about the stability of a four wheel drive moving in a curved path, taking gyroscopic couple into account. 8

(d) A uniform disc of 150 mm diameter has a mass of 5 kg. It is mounted centrally in bearings which maintain its axle in a horizontal plane. The disc spins about its axle with a constant speed of 100 r.p.m. while the axle precesses uniformly about the vertical

at 60 rpm. The directions of rotation are as shown in figure. If the distance between the bearings is 100 mm, find the resultant reaction at each bearing due to the mass and gyroscopic effects. 8



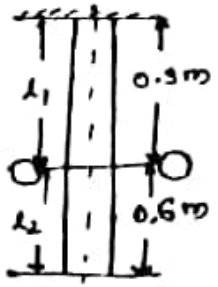
Unit-IV

4. (b) Explain the differnt types of free vibrations. 4

(b) Derive an expression for the natural frequency of free longitudinal vibration of equilibirum method. 8

(c) A flywheel is mounted on a vertical shaft as shown in Figure. The both ends of the shaft are fixed and its diameter is 50 mm. The flywheel has a mass of 500 kg. Find the natural frequencies of longitudinal and transverse vibrations. 8

Take $E = 200$ GN/m^2.



(d) Derive an expression for natural frequency of free torsional vibration. 8

Unit-V

5. (a) Explain the following : 4

(i) D-Alembert's principle

(ii) Coefficient of fluctuation of energy

(b) Discuss inertia forces in four bar chair. 8

(c) The crank and connecting rod of a steam engine are 0·3 m and 1·5 m in length. The crank rotates at 180 rpm. clockwise. Determine the velocity and acceleration of the piston when the crank is at 40 degree from the I.D.C. position. Also determine the position of the crank for zero acceleration of the piston. 8

(d) A single cylinder, single acting, four stroke gas engine develops 20 kW at 300 r.p.m. The work done by the gases during the expansion stroke is three times the work done on the gases during the compression stroke, the work done during the suction and exhaust strokes being negligbile. If the total fluctuation of speed is not to exceed ± 2 percent of the mean speed and the turning moment diagram during compression and expansion is assumed to be triangular in shape, find the moment of inertia of the flywheel. 8

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C037531(037)

B. Tech. (Fifth Semester) Examination, Nov.-Dec. 2023

(New Scheme)

(Mechanical Engineering Branch)

OPERATIONS RESEARCH

(BT3037)

Time Allowed : Three hours

Maximum Marks : 100

Minimum Pass Marks : 35

Note : *Attempt all questions. Each question consists of three parts. Part (a) of each question is compulsory. Attempt any* ***one*** *part from part (b) and (c).*

Unit-I

1. (a) Define degeneracy in LPP. What is meant by infeasible solution in a linear programming problem. **4**

(b) A company makes two kinds of leather belts, belt A and belt B. Belt A is a high-quality belt and belt B is of lower quality. The respective profits are ₹ 4 and ₹ 3 per belt. The production of each of type A requires twice as much as time as a belt of type B, and if all belts were of type B. The company could make 1000 belts per day. The supply of leather is sufficient for only 800 belts per day (both A and B combined). Belt A requires a fancy buckle and only 400 of these are available per day. There are only 700 buckles a day available for belt B. Formulate this problem as an L.P. Model. 8

Solve the following linear programming problem by Graphical Method : 8

Maximize $Z = 7x_1 + 5x_2$

Subject to $x_1 + 2x_2 \leq 6$

$4x_1 + 3x_2 \leq 12$

$x_1, x_2 \geq 0$

(c) A company has two grades of inspectors, 1 and 2 to undertake quality control inspection. At least 1500 pieces must be inspected in an 8-hour day. Grade

1 inspector can check 20 pieces in an hour with accuracy of 96% Grade 2 inspector can check 14 pieces in an hour with an accuracy of 92%. The daily wages of grade 1 inspector are ₹ 5 per hour while those of grade 2 inspector are ₹ 4 per hour any error made by an inspector costs ₹ 3 to the company. If there are, in all, 10 grade 1 inspectors and 15 grade 2 inspectors in the company, find the optimal assignment of inspectors that minimises the daily inspection cost. 16

(i) Formulate this problem as an L.P. Model

(ii) Solve it by Graphical method the determine the production schedule that yields the maximum profit.

Unit-II

2. (a) (i) What are the assumptions taken in Transportation Algorithm?

(ii) What is the application area of Assignment Technique? 4.

(b) A company has factories I, II, III and IV at four places, which supply warehouses A, B, C, D and E. Monthly capacity of these factories are 200, 175,

150 and 325 units respectively. Monthly warehouse requirements are 110, 90, 120, 230 and 160 units respectively. The table below gives the transportation costs. Determine the optimum cost of transportation. The only constraint is that transportation from I to B and IV to D is not possible. 16

	A	*B*	*C*	*D*	*E*
I	13	—	31	8	20
II	14	9	17	6	10
III	25	11	12	17	15
IV	10	21	13	—	17

(c) Two optimal solutions are possible for the following assignment problem. Determine both of them. 16

	I	*II*	*III*	*IV*	*V*	*VI*
A	7	5	7	9	6	4
B	9	8	6	8	—	5
C	8	6	7	4	3	9
D	9	8	9	6	9	8
E	8	—	9	7	4	7

Unit-III

3. (a) Explain the following with respect to the queue system : 4

(i) Queue discipline

(ii) Holiday time

(iii) Balking

(iv) Jockeying

(b) A maintenance service facility has Poisson arrival rates, negative exponential service times, and operates on a first-come first-served queue discipline. Breakdowns occur on an average of three per day with a range of zero to eight. The maintenance crew can service on an average six machines per day with a range from zero to seven. Find the 16

(i) Utilization factor of the service facility

(ii) Mean time in the system

(iii) Mean number in the system in breakdown or repair

(iv) Mean waiting time in the system

(v) Probability of finding 2 machines in the system

(vi) Expected number in the queue

(c) Arrival rate of telephone calls at a telephone booth are according to Poisson distribution, with an average time of 9 minutes between two consecutive arrivals. The length of telephone calls is assumed to be exponentially distributed, with mean 3 minutes. 16

(i) Determine the probability that a person arriving at the booth will have to wait.

(ii) Find the average queue length that is formed time to time.

(iii) The telephone company will install a second booth when convinced that an arrival would expect to have at least four minutes for the phone. Find the increase in flow rate of arrivals which will justify a second booth.

(iv) What is the probability that an arrival will have to wait for more than 10 minutes before the phone is free.

(v) What is the probability that he will have to wait for more than 10 minutes before the phone is available and the call is also complete.

(vi) Find the fraction of a day that the phone will be in use.

Unit-IV

4. (a) Differentiate between PERT and CPM. 4

(b) Construct a PERT network from the following information. Determine the optimum project duration, critical path and total float, free float, independent float and interference float : 16

Activity	Immediate Predecessor	t_0	t_m	t_p
A	Predecessor	1	2	3
B	A	2	4	6
C	A	2	6	10
D	B	6	8	10
E	C	4	6	8
F	C	6	10	14
G	E	8	10	12
H	F	12	14	16
I	G, H	4	8	12
J	G, H	10	12	14
K	I	2	4	6
L	J	6	10	14

(c) A project is compared of eleven activities, the time estimate for which are given below : 16

Activity	t_0	t_p	t_m (days)
1-2	7	17	9
1-3	10	60	20
1-4	5	15	10
2-5	50	110	65
2-6	30	50	40
3-6	50	90	55
3-7	1	9	5
4-7	40	68	48
5-8	5	15	10
6-8	20	52	27
7-8	30	50	40

(i) Draw the network diagram for the project.

(ii) Calculate slack for each node

(iii) Determine the critical path'

(iv) What is the probability of finishing the project in 125 days.

Unit-V

5. (a) What is simulation? Explain why is it used? 4

(b) Solve the following game : 16

1	−1	−1
−1	−1	3
−1	2	−1

(c) The occurrence of rain in a city on a day is dependent upon whether or not it rained on the previous day. If it rained on the previous day, the rain distribution is given by : 16

Event	Probability
No rain	0·50
1 cm rain	0·25
2 cm rain	0·15
3 cm rain	0·05
4 cm rain	0·03
5 cm rain	0·02

If it did not rain the previous day, the rain distribution is given by :

Event	Probability
No rain	0·75
1 cm rain	0·15

2 cm rain	0·06
3 cm rain	0·04

Simulate the city's weather for 10 days and determine by simulation the total days without rain as well as the total rainfall during the period. Use the sequence of random digits for simulation. Assume that for first day of the simulation it had not rained the day before.

67 63 39 55 29 78 70 06 78 76