

SHRI VENKATESHWARA UNIVERSITY



Syllabus

**Diploma
Mechanical Engineering
(Automobile)
IV semester
(THREE Years Programme)**

(w.e.f. 2019-20)

**SCHOOL OF ENGINEERING &
TECHNOLOGY**

SEMESTER- IV

Mechanical Engineering(Automobile) IV SEMESTER													
Sl No.	Subject Codes	Subject	Periods			Evaluation Scheme				End Semester		Total	Credit
			L	T	P	CT	TA	Total	PS	TE	PE		
1	PAE- 401	Advanced Automobile Engines	3	0	0	20	10	30		70		100	3
	PAE- 402	Automobile Transmission System	3	0	0	20	10	30		70		100	3
3	PAE-403	Automobile Manufacturing Process	3	0	0	20	10	30		70		100	3
4	PME- 402	Thermal Engineering - II	3	0	0	20	10	30		70		100	3
5	PME-403	Strength of Materials	3	0	0	20	10	30		70		100	3
6	PAE- 411	Advanced Automobile Engines Lab	0	0	2				10		15	25	1
7	PAE- 412	Automobile Transmission System Lab	0	0	2				10		15	25	1
8	PAE- 413	Automobile Manufacturing Process Lab	0	0	2				10		15	25	1
	PME- 412	Thermal Engineering – II Lab	0	0	2				10		15	25	1
9	PAE-414	Minor Project	0	0	4				50			50	2
10	PMC-418	Essence of Indian Knowledge and Tradition	2	0	0								0
Essence of Indian Knowledge and Tradition - Noncredit Mandatory courses												650	21

Course Code	:	PAE-401
Course Title	:	Advanced Automobile Engines
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Prerequisites	:	Computer Aided Machine Drawing Practice (MEPC104)
Course Category	:	PE

Objectives:

Students will be able to :

- Compare the properties of SI and CI engines fuel.
- Understand, describe and draw the stages of combustion in SI and CI engines.
- Understand and describe the pollutants emitted from S.I. and C.I. engines,
- Understand least emission norms and describe the methods of pollution control.
- Understand the drive cycle for measurement of pollutants.

Content [Theory] :

Chapter	Name of the Topic	Hours	Marks
	Fuels and Alternative Energy Options for Auto Engines:		

01	<p>1.1 Different types of fuels and their comparative calorific value.</p> <p>1.2 Properties of S.I. Engine fuel and C.I. Engine fuel. Octane number & Cetane number.</p> <p>1.3 Fuel additives and their effects.</p> <p>1.4 Gaseous fuels- LPG, CNG, Alcohol, Bio-Diesel, Hydrogen.</p> <p>1.5 LPG as SI engine fuel & LPG kit.</p> <p>1.6 Alcohol and gasoline fuel blend.</p> <p>1.7 Alcohol as CI engine fuel & its effect.</p> <p>1.8 Compressed Natural gas as a Transport (Diesel) fuel & CNG Kit.</p> <p>1.9 Electric cars and hybrid vehicles.</p>	07	--
02	<p>Scavenging:</p> <p>2.1 Introduction- Scavenging, Theoretical scavenging process – perfect scavenging, perfect mixing & short circuiting.</p> <p>2.2 Types of scavenging – uniflow, cross flow and loop or reverse scavenging. Scavenging pumps.</p>	03	
03	<p>Theory of Combustion:</p> <p>3.1 Ignition limits.</p> <p>3.2 Combustion theory in S.I. Engine.</p> <p>3.3 Stages of combustion in SI engine</p> <p>3.4 Ignition lag and Flame propagation, its effect on engine variables.</p> <p>3.5 Abnormal combustion- Detonation, pre-ignition, surface Ignition.</p> <p>3.6 Effects of detonation on engine performance & its control.</p> <p>3.7 SI engine combustion Chambers, types, construction & function.</p> <p>3.8 Combustion theory in C.I. Engine.</p> <p>3.9 Stages of combustion in CI engine.</p> <p>3.10 Air Fuel ratio in Diesel engines</p> <p>3.11 Delay period [physical delay & chemical delay] – significance and variables affecting delay period.</p> <p>3.12 Diesel knock and its control.</p> <p>3.13 Difference between knocking phenomena in S.I. and C.I. Engines.</p> <p>3.14 Factors that affect the design of CI engine combustion chamber.</p> <p>3.15 CI engine combustion chambers, types, construction & function.</p>	09	--
04	<p>Supercharging:</p> <p>4.1 Supercharging, purpose of supercharging, supercharging on S.I. & C.I. Engines.</p> <p>4.2 Effect of supercharging on power, efficiency and fuel consumption and its limitations on S.I. & C.I. engine.</p> <p>4.3 Advantages of supercharging on C.I. engines over S.I. engines.</p> <p>4.4 Types & Methods of Supercharging, Turbo charging & its use.</p>	04	

05	Part-I 5.1	Computer Controlled Fuel-Injection System [petrol engine]: 5.1.1 Necessity of petrol injection system, types of petrol injection System. 5.1.2 Throttle body injection (TBI) system/ Multi-Point fuel Injection system (MPFI) comparison with Carbureted engine fuel supply system. 5.1.3 Multi-Point fuel Injection system (MPFI)/ Port fuel injection (PFI) system. Types of injection sequential, grouped and simultaneous injections. Comparison of MPFI and TBI systems. 5.1.4 Electronic control module (ECM) control functions. 5.1.5 Inputs and outputs of electronic control module (ECM). 5.1.6 Output control functions- Fuel Injection control, Spark advance control, Idle speed control, Exhaust gas recirculation control and other controls.	08	--
	Part-II 5.2	Computer Controlled Fuel-Injection System [Diesel engine]: 5.2.1 Construction and working of electronic fuel Injector and in-tank fuel pump. 5.2.2 Diesel Engine Glow plugs Construction and circuit. Electronic injection advance. 5.2.3 Common rail direct injection [CRDI] system. Features of CRDI system. Block diagram of CRDI system. 5.2.4 Major Components- Fuel injector, EDC Electronic diesel control unit, High pressure fuel pump, High pressure accumulator and input from sensors (Camshaft position, coolant temp., Intake air temperature, crankshaft speed, Boost pressure, Rail pressure sensor, Air Mass meter)-function & identification. 5.2.4 CRDI System operation and advantages.	08	--
06		Fuel Economy, Air pollution and Emission Control : 6.1 Fuel economy standards and methods of improving fuel economy. 6.2 Sources of engine emissions. 6.3 Emissions from Petrol engines. 6.4 Factors that affect the Petrol engine emissions. 6.5 Effect of engine maintenance on exhaust emission. 6.6 Emissions from Diesel engines. 6.7 Factors that affect the Diesel engine emissions. 6.8 Comparison of diesel and gasoline emissions. 6.9 Emission control system for S.I. and C.I. engines – Catalytic Converter, Positive Crankcase Ventilation (PCV), Evaporation loss control device (ELCD) by charcoal canister, Exhaust Gas Re-circulation (EGR) method, Exhaust gas analyser – Smoke meter, Diesel smoke, Blue and Black smokes, Odour & Particulates and control. 6.10 Effects of emissions [Unburnt hydrocarbon, carbon monoxide, Nitric oxide, Lead particulate, Diesel Particulate Matter, Photo chemical Smog & Poly nuclear aromatic hydrocarbon etc.] on environment and human beings. 6.11 Euro Norms and Bharat stage Norms on engine emissions.	09	--
Total			48 hrs.	70 marks

Course Code	:	PAE-402
Course Title	:	Automobile Transmission System
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Course Category	:	AE

Objectives:			
Students will be able to:			
1. Know the principle, construction and working of elements of transmission system.			
2. Understand construction and working of various types of clutches.			
3. Understand construction and principle of working of various types of Gear Boxes.			
4. Understand working of final drive and differential action.			
Pre-requisite :-			
Content [Theory] :			
Chapter	Name of the Topic	Hours	Marks
01	Automobile Clutches: 1.1 Introduction, necessity, function and requirements of automotive Clutch. 1.2 Types of Automotive Clutch. - Friction and Non friction type Clutches. 1.3 Construction and Operation of Different type of clutches : 1.3.1 Construction and Operation of a single plate (coil and Diaphragm) dry disc clutch, multi plate, wet clutch. 1.3.2 Centrifugal and Semi-Centrifugal Clutch. 1.4 Construction details of Clutch plate. Clutch lining materials, Pressure Springs, Torsional Springs. 1.5 Clutch Linkage, Clutch Adjustments. Self Adjusting Clutch & Clutch Free Pedal Play. 1.6 Clutch operating mechanisms- Mechanical, Hydraulic & Vacuum. 1.7 Fluid Coupling – Principle, Construction and Working. 1.8 Common faults and remedies.	12	--

02	Part-I 2.1	Transmissions and Transaxles [Manual]: 2.1.1 Manual Transmissions and Transaxles, its'difference. 2.1.2 Purpose of the Transmission / Transaxle, Gear ratio and Torque. 2.1.3 Function and types of [Transmission] Gear Boxes - Sliding Mesh, Constant Mesh, Synchromesh gear box - Construction, operation of each type, Power flow diagram and comparison among them. 2.1.4 Forward and Reverse Gear Ratio of different vehicles. 2.1.5 Gear selector mechanism with gear lever on top of gear box. 2.1.6 Transfer case, function, construction & power flow layout. 2.1.7 Lubrication of gear box. 2.1.8 Common faults and remedies.	08	--
	Part-II 2.2	Transmissions and Transaxles [Automatic]: 2.2.1 Elements of Automatic Transmission. 2.2.2 Principle of Epi-cyclic Gearing. 2.2.3 Function, Construction & Working of Three member Epi-cyclic Gear box. 2.2.4 Torque Converter- Construction and working and application. 2.2.5 Freewheel Mechanism (Overrunning Clutch),Overdrive Mechanism. 2.2.6 Semi-Automatic Transmission, Control System. 2.2.7 Comparison with Conventional Transition System.	07	--
03		Universal Joints and Propeller shaft: 3.1 Necessity of Universal Joints. 3.2 Functions of universal joint and slip joint. 3.3 Types of Universal Joints, Constructional details of Universal Joint, Limitation of Universal Joint. 3.4 Constant Velocity Rezappa and Tripod Joint. 3.5 Necessity of Propeller shaft. 3.6 Function and constructional features of Propeller Shaft. 3.7 Whirling of shaft, Two-piece Propeller Shaft. 3.8 Common faults and remedies.	07	--
04		Final Drive and Differential : 4.1 Necessity of Final Drive. 4.2 Types of Gears used for Final Drive & their comparison. 4.3 Final Drive Ratio & Overall Gear Ratio. Final drive ratio of different types of vehicles. 4.4 Differential - Necessity of Differential. 4.5 Construction and working of differential. 4.6 Differential lock & Differential Slip. 4.7 Common troubles and remedies.	06	--

05	Rear Axle & Rear Axle Drive: 5.1 Necessity of Rear Axle. 5.2 Loads acting on the rear axles. 5.3 Types of rear axles [construction & working]- Semi floating, Three quarter floating and Full floating type. 5.4 Rear axle casing- split and banjo type, double reduction axles. 5.5 Rear Axle Drive –Types, construction and working principle of Hotchkiss Drive & Torque Tube Drive, its' use.	08	
Total		48 hrs	100 Marks
Learning Resources :			
Text Books :			
Author	Title	Publisher	
Dr. Kirpal Singh	Automobile Engg. Vol.-1	Standard Publishers	
R.B. Gupta	Automobile Engineering	Satya Prakashan	
Crouse & Angline	Automotive Mechanics	Tata McGraw Hill	
Joseph Heitner	Automotive Mechanics	East West Press, New Delhi	
John B. Heywood	Internal Combustion Engine Fundamentals	McGraw-Hill International Edition	
Automotive Mechanics	N.K. Giri vol-2	Khanna Publishers, New Delhi	
K.K. Ramlingam	Automobile Engineering	Scitech Publications	
Newton & Steed	Motor Vehicle	Butterwork Publication	
Auther W. Judge	Modern Transmission System	Chapman & Hall Ltd. London	
Auther W. Judge	Motor Manuals, Vol I to VI	Rober Bently Inc, Cambridge	
P.M. Heldt	The Automotive Chassis	Chilton Company, New York	

Course Code	:	PAE-403
Course Title	:	Automobile Manufacturing Process
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Course Category	:	AE

Objectives:

Students will be able to:

1. Know the forging process and it's use in manufacturing automobile parts.
2. Know the different press tools and their operations.
- 3 Understand different welding processes used in industry.
4. Selection and applications of different surface cleaning and coating processes.
5. Know the different methods of surface finishing.
6. Know about sub-systems of CNC machines.

Pre-requisite :-

Content [Theory] :

Chapter	Name of the Topic	Hours	Marks
01	Forging and Rolling: 1.1 Introduction. Forgeable materials and forgeability. 1.2 Classification of Forging process. 1.3 Advantages and limitation of forging process. 1.4 Forging by open and closed dies. 1.5 Forging sequences for Auto components - Connecting rod, Crankshaft, camshaft, spanner and gears. 1.6 Principles of rolling. Hot and cold rolling. 1.7 Types of rolling mills & Methods of rolling. 1.8 Rolled metal used in automobiles components.	07	
02	Press and press work: 2.1 Introduction. 2.2 Materials used in press work for automobile applications. 2.3 Classification of presses and terminology used in presses. 2.4 Major parts of mechanical press and their functions. 2.5 Press tools: Parts of standard die set. 2.6 Die accessories- Pilots, Stops, Strippers, Pressure pads and Knock	10	

	<p>outs.</p> <p>2.7 Types and construction of dies—Simple, progressive, compound and combination die.</p> <p>2.8 Press Operations : Punching, piercing, blanking, forming, drawing.</p> <p>2.9 Pressed components used in automobiles.</p>		
03	<p>Welding processes:</p> <p>3.1 Introduction. Classification and selection of welding process.</p> <p>3.2 Working principle of gas welding and types of flames.</p> <p>3.3 Oxy and acetylene cutting – Arc cutting.</p> <p>3.4 Arc welding process [principle, Equipment, Applications]: Metal Arc, TIG and MIG.</p> <p>3.5 Resistance welding: Spot, Projection, Seam and Butt welding.</p> <p>3.6 Aluminium and cast iron welding.</p> <p>3.7 Brazing and Soldering.</p> <p>3.8 Introduction to Plasma arc welding, specific application pertaining to auto industry. Safety practices in welding.</p> <p>3.9 Types of welded joints– merits and demerits of welded joints.</p> <p>3.10 Defects, Inspection and testing of welded joints – Destructive and Non destructive types of tests, Magnetic particle test, Radiographic and ultrasonic test.</p>	12	--
04	<p>Surface Treatment and finishing process:-</p> <p>4.1 Selection and use of surface treatment and finishing operations.</p> <p>4.2 Surface cleaning process: Blasting, Tumbling, Alkaline, Acid and Electrolytic cleaning.</p> <p>4.3 Metal surface coating : Electroplating, Galvanizing and Metal spraying,</p> <p>4.4 Surface finishing process: Lapping, Honing, Super finishing, Buffing, Burnishing.</p> <p>4.5 Applications (in auto industry), advantages and limitations.</p>	07	
05	<p>Powder Metallurgy :</p> <p>5.1 Introduction.</p> <p>5.2 Methods of manufacturing metal powders – Atomization, Reduction and electrolysis deposition – compacting – sintering –sizing –Infiltration.</p> <p>5.3 Rules of the powder metallurgy process.</p> <p>5.4 Mechanical properties of parts made by powder metallurgy.</p> <p>5.5 Applications in Auto industry.</p>	04	
06	<p>Introduction to CNC machines:-</p> <p>6.1 NC and CNC machines.</p> <p>6.2 Difference between conventional machines and CNCs.</p> <p>6.2 Classifications of CNC machines.</p> <p>6.3 Advantages and Disadvantages of CNC machines.</p> <p>6.4 Working principle of CNC machines.</p> <p>6.5 Principle of Computer aided part programming.</p> <p>6.6 Simple part programming on CNC machine for operations like Turning, Drilling and Milling.</p>	08	

Course Code	:	PME-403
Course Title	:	STRENGTH OF MATERIALS
Number of Credits	:	3 (L: 2, T: 1, P: 0)
Prerequisites	:	Engineering Mechanics (ESC201)
Course Category	:	PC

Course Learning Objectives

- To understand the concept of Simple Stresses and Strains.
- To understand the concept of Strain Energy.
- To understand the concept of Shear Force and Bending Moment Diagrams.
 - To understand the concept of Theory of Simple Bending and Deflection of Beams.
 - To understand the concept of Torsion in Shafts and Springs.
 - To understand the concept of Thin Cylindrical Shells

Course Content

UNIT-I: Simple Stresses and Strains: Types of forces; Stress, Strain and their nature; Mechanical properties of common engineering materials; Significance of various points on stress – strain diagram for M.S. and C.I. specimens; Significance of factor of safety; Relation between elastic constants; Stress and strain values in bodies of uniform section and of composite section under the influence of normal forces; Thermal stresses in bodies of uniform section and composite sections; Related numerical problems on the above topics.

Strain Energy: Strain energy or resilience, proof resilience and modulus of resilience; Derivation of strain energy for the following cases: i) Gradually applied load, ii) Suddenly applied load, iii) Impact/ shock load; Related numerical problems.

Unit-II: Shear Force & Bending Moment Diagrams: Types of beams with examples: a) Cantilever beam, b) Simply supported beam, c) Over hanging beam, d) Continuous beam, e) Fixed beam; Types of Loads – Point load, UDL and UVL; Definition and explanation of shear force and bending moment; Calculation of shear force and bending moment and drawing the S.F and B.M. diagrams by the analytical method only for the following cases: a) Cantilever with point loads, b) Cantilever with uniformly distributed load, c) Simply supported beam with point loads, d) Simply supported beam with UDL, e) Over hanging beam with point loads, at the centre and at free ends, f) Over hanging beam with UDL throughout, g) Combination of point and UDL for the above; Related numerical problems.

Unit-III: Theory of Simple Bending and Deflection of Beams: Explanation of terms: Neutral layer, Neutral Axis, Modulus of Section, Moment of Resistance, Bending stress, Radius of curvature; Assumptions in theory of simple bending; Bending Equation $M/I = \sigma/Y = E/R$ with derivation; Problems involving calculations of bending stress, modulus of section and moment of resistance; Calculation of safe loads and safe span and dimensions of cross-section; Definition and explanation of deflection as applied to beams; Deflection formulae without proof for cantilever and simply supported beams with point load and UDL only (Standard cases only); Related numerical problems.

Unit-IV: Torsion in Shafts and Springs: Definition and function of shaft; Calculation of polar M.I. for solid and hollow shafts; Assumptions in simple torsion; Derivation of the equation $T/J = f_s/R = G\theta/L$; Problems on design of shaft based on strength and rigidity; Numerical Problems related to comparison of strength and weight of solid and hollow shafts; Classification of springs; Nomenclature of closed coil helical spring; Deflection formula for closed coil helical spring (without derivation); stiffness of spring; Numerical problems on closed coil helical spring to find safe load, deflection, size of coil and number of coils.

Unit-V: Thin Cylindrical Shells: Explanation of longitudinal and hoop stresses in the light of circumferential and longitudinal failure of shell; Derivation of expressions for the longitudinal and hoop stress for seamless and seam shells; Related numerical Problems for safe thickness and safe working pressure.

Reference Books:

1. Strength of Materials, R. S. Khurmi, , S. Chand & Co., Ram Nagar, New Delhi – 2002
2. Strength of Materials, D.S. Bedi, Khanna Book Publishing Co., Delhi
3. Strength of Materials, S. Ramamrutham, 15 th Edn 2004, Dhanpat Rai Pub. Co., New Delhi.
4. Strength of Materials ,R.K. Bansal, Laxmi Publications Pvt. Ltd., New Delhi, 3rd Edition, 2010.
5. Strength of Materials, S. S. Rattan, Tata Mcgraw hill, New Delhi, 2008, ISBN 9780070668959
6. Strength of Materials, B K Sarkar, I Edition, 2003 Tata Mcgraw Hill, New Delhi.

Course outcomes:

At the end of the course, the student will be able to:

CO1	Compute stress and strain values and find the changes in axial, lateral and volumetric dimensions of bodies of uniform section and of composite section under the influence of normal forces.
CO2	Calculate thermal stresses, in bodies of uniform section and composite sections.
CO3	Define resilience, proof – resilience and modulus of resilience and obtain expressions for instantaneous stress developed in bodies subjected to different loads.
CO4	Compute shear force and bending moment at any section of beam and draw the S.F. & B.M diagrams of for UDL and Point loads.
CO5	Calculate the safe load, safe span and dimensions of cross section.
CO6	Compare strength and weight of solid and hollow shafts of the same length and material and compute the stress and deflection of the closed coil helical spring.

Course Code	:	PAE-411
Course Title	:	Advanced Automobile Engines Lab
Number of Credits	:	3 (L: 2, T: 1, P: 0)
Prerequisites	:	Advanced Automobile Engines

List of Practicals:

Total periods: 48hrs.

Skills to be developed :

1. Study of Cylinder Head and Combustion Chamber Identification:

[Using one 4-S (both Petrol & Diesel) engine and one 2-S engine]

- a) Removal of cylinder head of an engine. Observation of combustion chamber, location of valves, spark plug or Injector.
- b) Procedure to Decarbonise, cleaning of combustion chamber and refit.
- c) Interpret the type of combustion chamber. Sketch them and describe the construction. State the characteristics of the combustion chamber.
- d) Check the valve-seats for leakage. Check the condition of Spark Plug or fuel injector. Check the glow plug operation.

02 Valve Clearance Adjustment and Valve Timing Investigation:

- a) Perform Tappet setting of a single cylinder four-stroke engine.
- b) Perform Tappet setting of a multi cylinder four-stroke engine.
- c) Construct the Port timing diagram of a two-stroke engine.
- d) Construct the Valve timing diagram of a four-stroke engine.

03 Electronic Fuel Injection System troubleshooting /diagnosis: [with visit to a modern service station].

Diagnose Electronic fuel Injection system with diagnostic tester/ engine scanner.

- a) Perform On-Board diagnosis.
- b) Use Engine scanning tool for diagnosis.
- c) Locate various Components of Electronic fuel injection system.
- d) Identify components of EFI system.
- e) Perform stand-alone diagnosis using a Multi-meter and test lamp.

Course Code	:	PAE-413
Course Title	:	Automobile Transmission System Lab
Number of Credits	:	1 (L: 0T: 0P: 2)
Prerequisites	:	Advanced Automobile Engines

List of Practicals:	Total Periods: 32 hrs.
<p>Skills to be developed :</p> <ol style="list-style-type: none"> 1. Understand the layout, of “Vehicle Layout and Automobile Transmission System laboratory” and make use of various tools and measuring devices, write their specifications, application and care to be taken while using the same. 2. Observe and draw vehicle transmission layout of the following types: <ul style="list-style-type: none"> • Two wheeler • Three wheeler • Four wheeler 3. Dismantle and assemble a single plate dry type clutch assembly, to understand it’s construction and working. Sketch and label the components. 4. Dismantle and assemble a Multi-plate clutch assembly used in Two Wheelers, to understand its construction and working. Observe the operating linkages and sketch the system. Dismantle and assemble a Synchromesh gear box, to understand its construction and working. Observe gear shifting (synchronizing action), draw power flow diagrams, and calculate gear ratios. Dismantle and assemble a Propeller shaft, Slip joint and Universal Joint, to understand their construction and working. Sketch the same. 6. Dismantle and assemble the Differential and Rear axle, to understand its construction and working. Sketch the unit showing the exact location of the bearings. Find the gear ratio of final drive and identify the type of dismantled Rear axle. 5. Dismantle and assemble various-drive. Observe its’ construction and working. List the components dismantled and draw its’ sketches 	

Course Code	:	PAE-413
Course Title	:	Automobile Manufacturing Process Lab
Number of Credits	:	1 (L: 0T: 0 P: 2)
Prerequisites	:	Advanced Automobile Engines
List of Practicals:		Total Periods : 32 hrs.
Skills to be developed :		
<ol style="list-style-type: none"> 1. One job involving different milling operations such as key way cutting, gear cutting by indexing in a batch. 2. Study, sketch and measurement by Micrometer, Vernier Caliper, Vernier Height Gauge, Bore Dial Gauge & Dial Indicator. 3. One welding job (Arc/TIG/MIG/Resistance) to show the working principle of welding. 4. One simple part programming job on CNC machine. One job on CNC lathe having plain turning, taper turning, step turning, threading, boring and grooving. 5. Nondestructive testing of one or two defective casting / welding product- select & identify the types of testing procedure needed. 		
Note: All practical should be done in batches.		