INSTRUCTIONS:
Fill out the hazard analysis and risk assessment below.
HA-001 should be for the lane departure warning function as di
HA-002 should be for the lane keeping assistance function as c
Then come up with your own situations and hazards for the lane a
When finished, export your spreadsheet as a pdf file so that a revi

Hazard ID			
	Operational Mode	**Operational Scenario**	**Environmental Details**
HA-001			
HA-002			
HA-003			
HA-004			

iscussed in the lecture.
liscussed in the lecture.
assistance system. Fill in the HA-003 and HA-004 rows.
iewer can easily see your work.

Situational Analysis

Situation Details	Other Details (optional)	Item Usage (function)	Situation Description

Hazard Identification			
Function	**Deviation**	**Deviation Details**	**Hazardous Event (resulting effect)**
Lane Departure Warning (LDW)			
Lane Keeping			

Event Details	Hazardous Event Description	Exposure (of situation)

Hazardous Event Classification			
Rationale (for exposure)	**Severity (of potential harm)**	**Rationale (for severity)**	**Controllability (of hazardous event)**

	Determination of ASIL and Safety Goals	
Rationale (for controllability)	**ASIL Determination**	**Safety Goal**

Hazard ID	
	Operational Mode
HA-001	Normal Driving
HA-001	OM03 - Normal Driving
HA-002	OM03 - Normal Driving
HA-003	OM03 - Normal Driving
HA-004	OM04 – Backwards Driving

Hazard ID	
	Operational Mode
HA-001	OM03 - Normal Driving

HA-002	OM03 - Normal Driving
HA-003	OM03 - Normal Driving
HA-004	OM03 - Normal Driving
HA-005	OM03 - Normal Driving

Sit

Operational Scenario	Environmental Details
City Road	Normal Conditions
OS03 - Highway	EN01 - Normal conditions
OS02 - Country Road	EN04 - Snowfall (degraded view)
OS03 - Highway	EN01 - Normal conditions
OS02 - Country Road	EN06 -Rain (slippery road)

Si

Operational Scenario	Environmental Details
OS01 - City Road	EN01 - Normal conditions

OS01 - City Road	EN04 - Snowfall (degraded view)
OS03 - Highway	EN04 - Snowfall (degraded view)
OS02 - Country Road	EN01 - Normal conditions
OS02 - Country Road	EN04 - Snowfall (degraded view)

tuational Analysis

Situation Details (optional)	Other Details (optional)	Item Usage (function)
Low Speed	Night time + Obstacle on the road	Correctly Used
SD03 - High speed	Day time	Correctly Used
SD03 - Low speed	Night Time	Correctly Used
SD03 - High speed	Day time	Incorrectly used
SD03 - Low speed	Night Time	Incorrectly used

ituation Analysis

Situation Details (optional)	Other Details (optional)	Item Usage (function)
SD03 - Low speed	Night time + Obstacle on the road	IU01 - Correctly used

SD03 - Low speed	Night time + Obstacle on the road and no other illumination on road	IU01 - Correctly used
SD03 - High speed	Night time + Obstacle on the road or upcoming curve	IU01 - Correctly used
SD02 - High speed	Night time + Oncoming vehicle	IU01 - Correctly used
SD04 - High speed	Night time + Obstacle on the road and no other illumination on road	IU01 - Correctly used

Situation Description	Function	Deviation
Normal Driving on a City Road in Normal Conditions at Low Speed at Night with an Obstacle on the Road	Low beam illuminates the roadway in the dark	Function not activated
Normal Driving on Highway during daytime with High Speed	Lane Departure Function	DV 04 Actor effect is too much
Driving in Snowfall at Low speed at night	Lane Departure Function	DV 04 Actor effect is too much
Driving on a highway in normal conditions at high speed during the day	Lane Keeping Function	DV03 Function always activated
Driving at night on a country road backwards at low speed in Rain	Lane Keeping Function	DV03 Function always activated

Situation Description	Function	Deviation
Normal Driving on City Road during Normal conditions with Low speed (Night time + Obstacle on the road)	Low beam illuminates the roadway in the dark	DV01 - Function not activated

Normal Driving on City Road during Snowfall (degraded view) with Low speed (Night time + Obstacle on the road and no other illumination on road)	Low beam illuminates the roadway in the dark	DV01 - Function not activated
Normal Driving on Highway during Snowfall (degraded view) with High speed (Night time + Obstacle on the road or upcoming curve)	Low beam illuminates the roadway in the dark	DV01 - Function not activated
Normal Driving on Country Road during Normal conditions with High speed (Night time + Oncoming vehicle)	Low beam illuminates the roadway in the dark	DV01 - Function not activated
Normal Driving on Country Road during Snowfall (degraded view) with High speed (Night time + Obstacle on the road and no other illumination on road)	Low beam illuminates the roadway in the dark	DV01 - Function not activated

Hazard Identification	
Deviation Details	**Hazardous Event (resulting effect)**
Both headlights stop working	Front collision with obstacle
Lane departure warning vibration torque is too strong	EV00 Collision with other vehicle
Lane departure warning vibration torque is too strong	EV04 Car comes off the road
Lane Keeping Function is always activated	EV00 Collision with other vehicle
Lane Keeping Function is always activated	EV00 Collision with other vehicle

Hazard Identification	
Deviation Details	**Hazardous Event (resulting effect)**
Both headlights stop working	EV04 - Front collision with obstacle

Both headlights stop working	EV04 - Front collision with obstacle
Both headlights stop working	EV04 - Front collision with obstacle
Both headlights stop working	EV08 - Collision with other vehicle
Both headlights stop working	EV04 - Front collision with obstacle

Event Details	Hazardous Event Description	Exposure (of situation)
Vehicle crashes into the obstacle with injury to driver	Total loss of low beam	E4 - High probability
Vehicle crashes into oncoming vehicle or vehicle to side	Lane Departure Warning system apply s too high level of torque to steering wheel	E4 - High probability
Vehicle crashes into side of road or falls off edge of road	Lane Departure Warning system apply s too high level of torque to steering wheel	E2- Low probability
Driver is using car as if self driving	Driver not using function as designed	E3 – Medium Probability
Driver is using car as if self driving	Driver not using function as designed	E2- Low probability

Event Details	Hazardous Event Description	Exposure (of situation)
Vehicle crashes into the obstacle with injury to driver	Total loss of low beam	E4 - High probability

Vehicle crashes into the obstacle with injury to driver	Total loss of low beam	E1 - Very low probability
Vehicle crashes into the obstacle or road infrastructure with injury to driver and any others present	Total loss of low beam	E2 - Low probability
Vehicle crashes into the oncoming vechile or road infrastructure	Total loss of low beam	E4 - High probability
Vehicle crashes into the obstacle or road infrastructure with injury to driver and any others present	Total loss of low beam	E2 - Low probability

Hazardous

Rationale (for exposure)	Severity (of potential harm)
night driving in the city is a regular activity	S1 - Light and moderate injuries
Driving during the day on a highway is a regular activity	S3 - Life-threatening or fatal injuries
Driving at night in snow on a country road is not a regular activity	S2 - Severe and life-threatening injuries
Driving in normal conditions on highway is a regular activity	S3 - Life-threatening or fatal injuries
Driving on country road at night backwards is not a regular activity	S3 - Life-threatening or fatal injuries

Hazardous

Rationale (for exposure)	Severity (of potential harm)
night driving in the city is a regular activity	S1 - Light and moderate injuries

night driving in the city on completely unilluminated roads while it is snowing is rare	S1 - Light and moderate injuries
High driving is part of regular driving, however, heavy snow occurs a few times a year	S3 - Life-threatening or fatal injuries
country driving is part of regular driving	S3 - Life-threatening or fatal injuries
country driving is part of regular driving, however, heavy snow occurs a few times a year	S3 - Life-threatening or fatal injuries

Event Classification

Rationale (for severity)	Controllability (of hazardous event)
In city traffiic, speed of vehicle is expected to be low	C0 - Controllable in general
At high speed on a highway an oncoming car collision could be fatal	C3 Difficult to control or uncontrollable
At low speed on a country road sliding or falling off the road will damage a car but should be survivable	C3 Difficult to control or uncontrollable
At high speed on a highway an oncoming car collision could be fatal	C3 Difficult to control or uncontrollable
At low speed reversing the car could collide with a forward travelling car in the same lane which might be going at high speed	C3 Difficult to control or uncontrollable

Event Classification

Rationale (for severity)	Controllability (of hazardous event)
In city traffiic, speed of vehicle is expected to be low	C0 - Controllable in general

In city traffiic, speed of vehicle is expected to be low	C1 - Simply controllable
On highway speed of vehicle is expected to be high	C2 - Normally controllable
On country roads speed of vehicle is expected to be high	C1 - Simply controllable
On country roads speed of vehicle is expected to be high	C3 - Difficult to control or uncontrollable

	Determination of ASIL
Rationale (for controllability)	**ASIL Determination**
At city speed, most drivers will be able to control the situation by applying brakes and there is additional illmunitation on city roads	QM
IT is unlikely a human would be able to completely overpower the torque from the device and do so nearly instantly	D
IT is unlikely a human would be able to completely overpower the torque from the device and do so nearly instantly	B
IF the driver is not paying attention then the driver cannot counteract problem	C
IF the driver is not paying attention then the driver cannot counteract problem	B

	Determination of ASIL
Rationale (for controllability)	**ASIL Determination**
At city speed, most drivers will be able to control the situation by applying brakes and there is additional illmunitation on city roads	QM

On completely unilluminated city roads, drivers usually drive at lower end of city speeds and hence are expected to be able to control vehicle	QM
When driving on highway with low beam, it can be expected that there are other vehicles and there is some form of illumination on road and hence >90% drivers are able to brake and control the vehicle. And also use other forms of warning (e.g. hazard lights) to signal malfunction	A
Since there is usually no other form of illumination to be expected on country road, it will be difficult for the average driver to control the vehicle in such a situation	B
Since there is usually no other form of illumination to be expected on country road, it will be difficult for the average driver to control the vehicle in such a situation	B

. and Safety Goals
Safety Goal
Total Loss of Beam Shall Be Prevented
Torque from the Lane Departure Function shall be limited in power and duration so as not to affect the drivers ability to steer the vehicle
Torque from the Lane Departure Function shall be limited in power and duration so as not to affect the drivers ability to steer the vehicle
The Lane keeping Function shall be limited in use by duration and frequency to ensure it is not constantly on as a substitute for a self driving mode
The Lane keeping Function shall be limited in use by duration and frequency to ensure it is not constantly on as a substitute for a self driving mode

. and Safety Goals
Safety Goal
Total loss of low beam shall be prevented

Total loss of low beam shall be prevented
Total loss of low beam shall be prevented
Total loss of low beam shall be prevented
Total loss of low beam shall be prevented

Hazard & Risk Analysis Defir

Operational Mode

ID	Mode
OM01	Parked
OM02	Ignition on
OM03	Normal driving
OM04	Backward driving
OM05	Degraded driving
OM06	Towing (active)
OM07	Towing (passive)
OM08	Service
OM09	N/A

Operational Scenario

ID	Scenario
OS01	Any Road
OS02	City Road
OS03	Country Road
OS04	Highway
OS05	Mountain Pass
OS06	Off Road
OS07	Road with gradient
OS08	Road with bump
OS09	Road tunnel
OS10	Road with construction site
OS11	N/A

Situation Details

ID	Scenario
SD01	Low speed
SD02	High speed
SD03	Normal acceleration
SD04	High acceleration
SD05	Normal braking
SD06	High braking
SD07	N/A

Item Usage

ID	Mode
IU01	Correctly used
IU02	Incorrectly used
IU03	N/A

Environmental Details

ID	Scenario

EN01	Normal conditions
EN02	Sun blares (degraded view)
EN03	Fog (degraded view)
EN04	Snowfall (degraded view)
EN05	Cross-wind (lateral force)
EN06	Rain (slippery road)
EN07	Snow (slippery road)
EN08	Glace (slippery road)
EN09	N/A

nitions

Remarks
Car is parked, ignition is off
Car is parked, ignition is on
Car is driving
Car is driving
Limp home mode
Towing another car
Beeing towed by another car
Vehicle is in repair garage
not applicable or not relevant

Remarks
road type
road type
road type
road type
road type
road type
road attribute
road attribute
road attribute
road attribute
not applicable or not relevant

Remarks
driving attribute
driving attribute
driving attribute
driving attribute
driving attribute
driving attribute
not applicable or not relevant

Remarks
Intended usage
Unintended usage (foreseeable)
not applicable or not relevant

Remarks

weather attribute
weather attribute
weather attribute
weather attribute
weather attribute
road attribute
road attribute
road attribute
not applicable or not relevant

Reference
OM01 - Parked
OM02 - Ignition on
OM03 - Normal driving
OM04 - Backward driving
OM05 - Degraded driving
OM06 - Towing (active)
OM07 - Towing (passive)
OM08 - Service
OM09 - N/A

Reference
OS01 - Any Road
OS02 - City Road
OS03 - Country Road
OS04 - Highway
OS05 - Mountain Pass
OS06 - Off Road
OS07 - Road with gradient
OS08 - Road with bump
OS09 - Road tunnel
OS10 - Road with construction site
OS11 - N/A

Reference
SD01 - Low speed
SD02 - High speed
SD03 - Normal acceleration
SD04 - High acceleration
SD05 - Normal braking
SD06 - High braking
SD07 - N/A

Reference
IU01 - Correctly used
IU02 - Incorrectly used
IU03 - N/A

Reference

EN01 - Normal conditions
EN02 - Sun blares (degraded view)
EN03 - Fog (degraded view)
EN04 - Snowfall (degraded view)
EN05 - Cross-wind (lateral force)
EN06 - Rain (slippery road)
EN07 - Snow (slippery road)
EN08 - Glace (slippery road)
EN09 - N/A

Deviation

ID	Deviation (Guideword)	Remarks
DV01	Function not activated	Activation error
DV02	Function unexpectedly activated	Activation error
DV03	Function always activated	Activation error
DV04	Actor effect is too much	Quantitative error
DV05	Actor effect is too less	Quantitative error
DV06	Actor action too early	Timing error
DV07	Actor action too late	Timing error
DV08	Actor action before	Sequence error
DV09	Actor action after	Sequence error
DV10	Actor effect is reverse	Logical error
DV11	Actor effect is wrong	Logical error
DV12	Sensor sensitivity is too high	Quantitative error
DV13	Sensor sensitivity is too low	Quantitative error
DV14	Sensor detection too early	Timing error
DV15	Sensor detection too late	Timing error
DV16	Sensor detection before	Sequence error
DV17	Sensor detection after	Sequence error
DV18	Sensor detection is reverse	Logical error
DV19	Sensor detection is wrong	Logical error
DV20	N/A	not applicable or not relevant

Hazardous Events (possibe effects)

ID	Hazardous Event	Remarks
EV-07	None	
EV-06	Front collision with oncoming traffic	
EV-05	Front collision with ahead traffic	
EV-04	Front collision with obstacle	
EV-03	Rear collision with trailing traffic	
EV-02	Side collision with other traffic	
EV-01	Side collision with obstacle	
EV00	Collision with other vehicle	
EV01	Collision with train	
EV02	Collision with pedestrian	
EV03	Car spins out of control	
EV04	Car comes off the road	
EV05	Car catches file	
EV06	N/A	

Reference
DV01 - Function not activated
DV02 - Function unexpectedly activated
DV03 - Function always activated
DV04 - Actor effect is too much
DV05 - Actor effect is too less
DV06 - Actor action too early
DV07 - Actor action too late
DV08 - Actor action before
DV09 - Actor action after
DV10 - Actor effect is reverse
DV11 - Actor effect is wrong
DV12 - Sensor sensitivity is too high
DV13 - Sensor sensitivity is too low
DV14 - Sensor detection too early
DV15 - Sensor detection too late
DV16 - Sensor detection before
DV17 - Sensor detection after
DV18 - Sensor detection is reverse
DV19 - Sensor detection is wrong
DV20 - N/A

Reference
EV-07 - None
EV-06 - Front collision with oncoming traffic
EV-05 - Front collision with ahead traffic
EV-04 - Front collision with obstacle
EV-03 - Rear collision with trailing traffic
EV-02 - Side collision with other traffic
EV-01 - Side collision with obstacle
EV00 - Collision with other vehicle
EV01 - Collision with train
EV02 - Collision with pedestrian
EV03 - Car spins out of control
EV04 - Car comes off the road
EV05 - Car catches file
EV06 - N/A

Exposure

ID	Description
E0	Incredible
E1	Very low probability
E2	Low probability
E3	Medium probability
E4	High probability

Severity

ID	Description
S0	No injuries
S1	Light and moderate injuries
S2	Severe and life-threatening injuries
S3	Life-threatening or fatal injuries

Controllability

ID	Description
C0	Controllable in general
C1	Simply controllable
C2	Normally controllable
C3	Difficult to control or uncontrollable

Duration (of situation)
Not specified
<1 % of average operating time
1 % to 10 % of average operating time
>10 % of average operating time

Remarks
No injuries
Light and moderate injuries
Severe and life-threatening injuries (survival probable)
Life-threatening injuries (survival uncertain), fatal injuries

Remarks
Controllable in general
99 % or more of all drivers or other traffic participants are usuall
90 % or more of all drivers or other traffic participants are usuall
Less than 90 % of all drivers or other traffic participants are usua

Frequency (of situation)	Reference
	E0 - Incredible
Occurs less often than once a year for the great majority of drive	E1 - Very low probability
Occurs a few times a year for the great majority of drivers	E2 - Low probability
Occurs once a month or more often for an average driver	E3 - Medium probability
Occurs during almost every drive on average	E4 - High probability

Probability of Injuries	Reference
AIS 0 and less than 10 % probability of AIS 1-6	S0 - No injuries
More than 10 % probability of AIS 1-6 (and not S2 or S3)	S1 - Light and moderate injuries
More than 10 % probability of AIS 3-6 (and not S3)	S2 - Severe and life-threatening injuries
More than 10 % probability of AIS 5-6	S3 - Life-threatening or fatal injuries

	Reference
	C0 - Controllable in general
y able to avoid harm	C1 - Simply controllable
y able to avoid harm	C2 - Normally controllable
ally able, or barely able, to avoid harm	C3 - Difficult to control or uncontrollable

Controllability	Exposure	Severity		
		S0	S1	S2
C1	E1	QM	QM	QM
	E2	QM	QM	QM
	E3	QM	QM	QM
	E4	QM	QM	A
C2	E1	QM	QM	QM
	E2	QM	QM	QM
	E3	QM	QM	A
	E4	QM	A	B
C3	E1	QM	QM	QM
	E2	QM	QM	A
	E3	QM	A	B
	E4	QM	B	C

S3
QM
QM
A
B
QM
A
B
C
A
B
C
D